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Lizardite-chlorite structural relationships and an inferred high-pressure lizardite polytype

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Abstract

We determined details of the layer stackings in lizardite (variety: baltimorite) and chlorite in a splintery sample from a massive serpentinite. Based on high-resolution transmission electron microscopy (HRTEM) and image simulations, we localized the positions of projected columns of tetrahedral (T) and octahedral (O) cations that allow determination of the nature of the transformation of lizardite to chlorite and the structural formula of the chlorite. The lizardite stacking is of an unexpected type because adjacent layers are in non-hydrogen-bonded placements, a configuration that permits easy, strain-free transformation to chlorite. We conclude that the lizardite-chlorite transformation was isochemical and at constant volume. A consequence is that the product chlorite consists of neutral brucite- and talc-type layers and so can be regarded as a 1:1 interstratification of brucite and talc. Both the T and the O sheets in talc-type layers contain M^{3+} (M = Al, Fe, Cr, ...) cations. An implication of our results combined with high-pressure studies of chlorite and TO silicates is that lizardite stacking sequences can indicate whether a given crystal has been subjected to high pressures. Lizardite in non-hydrogen-bonded sequences presumably has this configuration because of its prior exposure to elevated pressures and can thus be added to the list of indicators of past high pressure. Calibration of this new geobarometer remains for the future.